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PŮVODNÍ PRÁCE

Evaluation of the Diagnostic Accuracy of Percutaneous Core Needle Biopsy in Bone and Soft Tissue Tumors

Hodnocení diagnostické přesnosti perkutánní jádrové jehlové biopsie u nádorů kostí a měkkých tkání

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ABSTRACT

PURPOSE OF THE STUDY

Open (incisional) biopsies have long been accepted as the gold standard in diagnosing bone and soft tissue tumors. However, the main disadvantage of this method is that it can lead to increased contamination, hematoma, infection, and pathological fracture. Compared to open biopsies, percutaneous core needle biopsies are less invasive, do not require hospitalization, have low costs and low complication rates, and there is no need for wound healing in cases that require radiotherapy. This study evaluated the diagnostic accuracy and reliability of percutaneous core needle biopsy.

MATERIAL AND METHODS

The study included the results of 250 percutaneous core needle biopsies of 244 patients who presented at the tertiary university hospital between September 2012 – September 2022 and were diagnosed with a bone or soft tissue tumor using the percutaneous core needle biopsy method and then underwent surgical excision in the Orthopaedics and Traumatology Clinic. The sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and diagnostic accuracy rates were calculated for the percutaneous core needle biopsy method according to the compatibility of the results.

RESULTS

A fluoroscopy-guided percutaneous Jamshidi needle biopsy performed by an orthopedist for lesions originating from the bone has a diagnostic accuracy of 96%. CT-guided percutaneous Jamshidi needle biopsy performed by a radiologist for lesions originating from the bone has a diagnostic accuracy of 88.9%. Percutaneous Tru-cut needle biopsy performed by an orthopedist without imaging guidance for lesions originating from soft tissue has a diagnostic accuracy of 92%. USG-guided percutaneous Tru-cut needle biopsy performed by a radiologist for lesions originating from soft tissue has a diagnostic accuracy of 96,7% ($p<0.001$).

DISCUSSION

The diagnostic accuracy of open biopsies ranges from 91% to 99% in the literature. Additionally, the diagnostic accuracy of core needle biopsies in recent studies ranges from 76% to 99%. Compared to the literature, our study has shown that biopsies performed by orthopedic specialists have a high diagnostic power (96% for bone-derived lesions; 92% for soft tissue-derived lesions).

CONCLUSIONS

Percutaneous core needle biopsy is highly effective and reliable in diagnosing bone and soft tissue tumors. Managing patients by a team using a multidisciplinary approach will increase diagnostic success.

Key words: core needle biopsy, percutaneous, diagnostic accuracy, radiology guided biopsy, bone and soft tissue tumors.

INTRODUCTION

A biopsy combines the words “bios,” meaning life, and “opsis,” meaning view. In other terms, biopsy means “view of life.” The main topic of oncology is the evaluation of the biological characteristics of the tumor (6). Biopsy has become an even more critical step since the limb-sparing surgery became the primary goal in orthopedic oncology. Clinical, radiological, and histopathological data should be evaluated by an experienced team with a multidisciplinary approach to guide the biopsy.

Traditional open biopsies have long been considered the gold standard diagnostic method (3, 14, 18, 22, 23). The reported diagnostic accuracy of this method ranges from 91% to 99% (18, 22, 24). The main benefit of open biopsies is the ability to obtain sufficient tissue samples for histological analysis. However, additional risks are associated with this procedure, including hematoma, infection, and tumor cell spread (15). Patients more easily tolerate percutaneous biopsies as they are less invasive than open biopsies. It is a method that does not require hospitalization and has a low cost and low complication risk. The diagnostic accuracy of core needle biopsies ranges from 76% to 99% in the literature (1, 2, 19, 22, 24).

While reviewing previous articles on biopsies for bone and soft tissue lesions, many studies compared open (incisional) biopsies with imaging-guided needle biopsies. However, little evidence supports the diagnostic accuracy of non-imaging-guided core needle biopsies (18). This is the main problem with core needle biopsy of soft tissue tumors in the literature; so far, there are only two studies published on this topic (16, 18). Therefore, while conducting the study, we tried to answer the following three questions, which constitute the study's main purpose:

(1) Are core needle biopsies effective and safe in diagnosing bone and soft tissue tumors?

(2) What should the approach be for patients not diagnosed with core needle biopsies?

(3) Is there a difference in the diagnostic success of core needle biopsies performed with and without image guidance?

MATERIAL AND METHODS

The study was carried out in Department of Orthopedics and Traumatology, Ondokuz Mayis University Hospital, Samsun, Turkey.

During the ten years between September 2012 and September 2022, 250 percutaneous core needle biopsy results of 244 patients who were diagnosed with bone or soft tissue tumors by percutaneous core needle biopsy method and underwent surgical excision in our clinic were included in the study. To assess the precision and reliability of percutaneous core needle biopsy techniques for primary diagnosis, we excluded individuals with prior diagnoses of bone or soft tissue tumors from a different medical facility. Our study included patients who were referred to the Orthopedics Clinic with suspicion of a tumor, based on clinical and radiological parameters and who were then evaluated by the Bone and Soft Tissue Tumor Council, underwent biopsy, and were treated surgically. Patients who did not comply with the follow-up program at any stage of diagnosis or treatment and experienced a lack of information and data loss in the hospital's digital database and file archive were also excluded from the study. In addition, as a result of the evaluation of the patients with a multidisciplinary approach in the Bone and Soft Tissue Tumors Council, benign lesions that can be diagnosed with typical clinical and radiological findings and patients diagnosed with open biopsy were excluded from the study.

Biopsies were performed following the standard biopsy procedures. In patients whose soft tissue mass is palpable and far from neurovascular structures, a biopsy is performed under local anesthesia, usually in outpatient settings and without the guidance of imaging methods. If the soft tissue lesion is located deep, non-palpable, and close to neurovascular structures, an imaging-guided biopsy is planned in consultation with the Radiology department. In lesions originating from bone tissue, a biopsy is performed by hospitalizing the patients, usually in operating room conditions, under fluoroscopy guidance, and after providing patient sedation. Again, an imaging-guided needle biopsy is planned in consultation with the Radiology department in bone lesions that are located deep where the neurovascular structures are at risk.

The lesions of the patients were divided into two groups, bone and soft tissue, according to the tissue of origin. Then, both the needle biopsy results and the biopsy results obtained from the surgical treatment were examined in 5 subclasses: Benign, Intermediate Form, Malignant, Metastasis, and Non-Tumor Lesions, taking into account the clinical and radiological behaviors. While creating these five subclasses, the Bone and Soft Tissue Tumors classification published by the World Health Organization in 2020 was taken as the basis (4). Lesions such as myositis ossificans, tumoral calcinosis, and hematoma, primarily bone and soft tissue infections, are non-tumor lesions.

The patients' percutaneous core needle biopsy results were compared with the surgical results accepted as the reference diagnosis. Percutaneous biopsy results were divided into four groups according to their compatibility with the final histopathology results obtained after surgical excision, their guidance in the diagnosis, and their adequacy in making the diagnosis:

i. Compatible: Percutaneous biopsy results that have the same diagnosis as the final histopathology results after surgical excision or that provide sufficient information for the treatment decision (for example, a malignant mesenchymal tumor whose specific type cannot be determined) in the light of clinical and radiological data, although the tumor subgroup cannot be specified, was evaluated as "compatible".

ii. Incompatible: Final histopathology results after surgical excision and the percutaneous biopsy results with a different diagnosis were evaluated as "incompatible".

iii. Suspicious: Patients whose percutaneous biopsy results did not provide a definitive diagnosis or did not guide the treatment plan were evaluated as "suspicious".

iv. Non-Diagnostic Material: Samples that did not have enough tissue samples for diagnosis due to percutaneous biopsy were evaluated in the "non-diagnostic material" group.

These four groups, which showed consistency between biopsies, were created and subclassified for data analysis. The use of these subclasses is explained in the *Data Analysis* section below.

Data analysis

Final histopathological diagnoses obtained after surgery were taken as a reference to evaluate the diagnostic accuracy of percutaneous core needle biopsy. According to the tissue of origin, lesions were divided into two groups: bone and soft tissue. Then, the results of the biopsies were divided into positive and negative subgroups according to their detection of the malignancy for analysis. The way to do this is as follows: Patients whose percutaneous core needle biopsy results were reported as "benign, intermediate form, non-tumor lesion or non-diagnostic material" were considered "Negative (no disease/malignancy)"; Patients reported as "malignant or metastases" were accepted as "Positive (disease/malignant)".

While evaluating the patients in the "suspicious" group with percutaneous core needle biopsy results, each diagnosis was separately assessed as positive or negative, considering the compatibility between the suspected diagnosis and the final diagnosis. Finally, when evaluating the patients in the "incompatible" group with the results of percutaneous core needle biopsy, the definitive histopathological diagnosis obtained after surgery was taken as a reference to indicate the diagnostic incompatibility. If the surgical biopsy result was positive, the needle biopsy was considered negative, and if the surgical biopsy result was negative, the needle biopsy was considered positive. Similarly, surgical biopsy results are divided into two groups: "Positive (disease/malignant) and Negative (no disease/malignant)". Sensitivity, specificity, Positive Predictive Value (PPV), Negative Predictive Value (NPV), and diagnostic accuracy rates of percutaneous core needle biopsy methods were calculated according to the compatibility of the results.

Ethical approval

This retrospective study was conducted with the approval of the Ondokuz Mayıs University Clinical Research Ethics Committee (Approval number: 2023/30). Institutional Review Board approval and informed consent of the patients were obtained before the biopsy.

Statistical analysis

IBM SPSS V23 was utilized for data analysis. The categorical data was compared among groups using the Pearson chi-square test. Kappa values assessed the concordance between the percutaneous core needle biopsy diagnosis and the final diagnosis was obtained through surgical excision. Analysis results were presented as mean ± standard deviation and median (minimum-maximum) for quantitative data and frequency (percent) for categorical data. The significance level was taken as $p<0.001$.

RESULTS

Of the 244 patients included in the study, 130 (53.3%) were men, and 114 (46.7%) were women. The mean age of the patients was 49.93 ± 22.18 years. The lesion originated from bone tissue in 102 patients (41.8%), and the lesion originated from soft tissue in 142 patients (58.2%). Of 250 percutaneous core needle biopsies performed on 244 patients, 163 (65.2%) were performed by an orthopedist, and 87 (34.8%) were performed by a radiologist under image guidance (Table 1). Lesions originating from bone were most commonly located in the femur (44 patients, 43.1%). Lesions originating from soft tissue were most commonly located in the thigh region (29 patients, 20.4%). When the distribution of the final diagnoses of 244 patients according to the Classification of Bone and Soft Tissue Tumors of the World Health Organization was examined, 55 (22.5%) were benign, 131 (53.7%) were malignant, and 33 (13.5%) were found as an intermediate form, 15 (6.1%) as metastasis and 10 (4.1%) non-tumor lesions (Fig. 1).

In our investigation, osteosarcoma emerged as the predominant primary malignant bone tumor (25 patients, 24.5%), while aneurysmal bone cyst stood out as the most prevalent benign tumor (7 patients, 6.9%). Additionally, the leading intermediate form tumor was identified as a giant cell bone tumor (10 patients, 9.8%). In the realm of soft tissue, pleomorphic sarcoma took precedence as the most prevalent primary malignant tumor (17 patients, 12%), benign lipomatous tumor family ranked as the most common benign tumor (18 patients, 12.7%), and desmoid-type fibromatosis was the prevailing intermediate form tumor (8 patients, 5.6%). The lesions' percutaneous core needle biopsy results were compared with the final pathology results after surgery, which were taken as a reference in the diagnosis. As a result of this comparison, 219 patients

Table 1. Descriptive statistics of patients included in the study

	Frequency (n) / Mean (s. deviation)	Percent (%) / Median (min.–max.)
Gender		
Men	130	53.3
Women	114	46.7
Age	49.93±22.18	41.5 (1–87)
Bone / Soft tissue		
Bone	102	41.8
Soft tissue	142	58.2
Side localization of lesions		
Right	117	48
Left	127	52
The physician performing the needle biopsy		
Radiologist	87	34.8
Orthopedist	163	65.2

(89.8%) were in the "compatible" group, four patients (1.6%) were in the "incompatible" group, five patients (2%) were in the "suspicious" group, and 16 patients (6.6%) were included in the group of ''non-diagnostic material''.

(1) Are core needle biopsies effective and safe in diagnosing bone and soft tissue tumors?

Fluoroscopy-guided percutaneous Jamshidi needle biopsy performed by an orthopedist for lesions originating from the bone has a sensitivity of 96.2%, a specificity of 95.5%, a PPV of 98.1, an NPV of 91.3%, and a diagnostic accuracy of 96%. CT-guided percutaneous Jamshidi needle biopsy performed by the radiologist for lesions originating from the bone has a sensitivity of 90%, a specificity of 85.7%, a PPV of 94.7%, an NPV of 75%, and a diagnostic accuracy of 88.9% (Table 2).

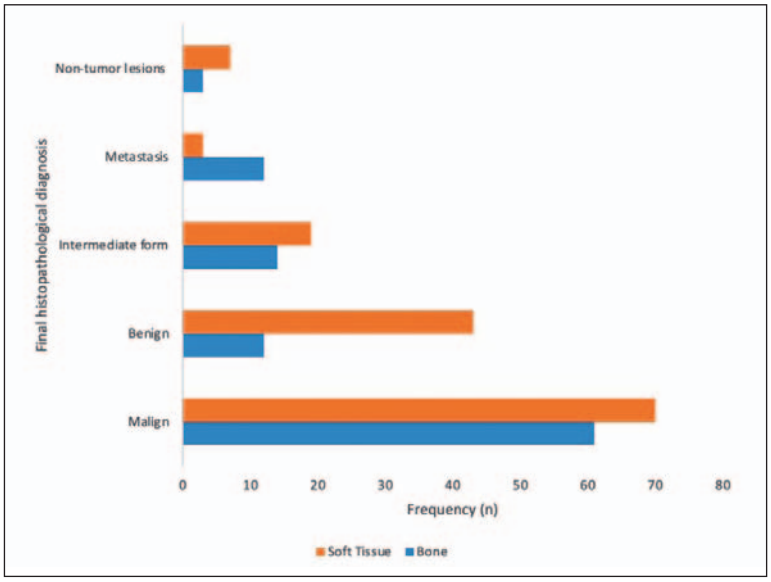

Fig. 1. Distribution of the final diagnosis by separating the lesions according to the tissue of origin.

Percutaneous Tru-cut needle biopsy performed by an orthopedist without imaging guidance for lesions originating from soft tissue had a sensitivity of 89.1%, a specificity of 95.2%, a PPV of 95.3%, an NPV of 88.9%, and a diagnostic accuracy of 92% (p<0.001). USG-guided percutaneous Tru-cut needle biopsy performed by a radiologist for lesions originating from soft tissue has a sensitivity of 96.8%, a specificity of 96.6%, a PPV of 96.8%, an NPV of 96.6%, and a diagnostic accuracy of 96,7% (Table 2).

Following the statistical examination of biopsy outcomes, irrespective of the administering physician utilizing the closed biopsy technique, the percutaneous Jamshidi needle biopsy demonstrated a sensitivity of 94.5%, specificity of 93.1%, positive predictive value (PPV) of 97.2%, negative predictive value (NPV) of

Table 2. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and diagnostic accuracy of percutaneous core needle biopsy methods in bone and soft tissue lesions

Physician performing needle biopsy	Bone/Soft tissue	Needle Biopsy Result	Final Diagnosis		Kappa	p	Sensitivity	Specificity	PPV	NPV	Diagnostic accuracy
			Negative	Positive							
Orthopedist	Bone	Negative	21 (95.5)	2 (3.8)	0.905	<0.001	96.2%	95.5%	98.1%	91.3%	96.0%
		Positive	1 (4.5)	51 (96.2)							
	Soft tissue	Negative	40 (95.2)	5 (10.9)	0.841	<0.001	89.1%	95.2%	95.3%	88.9%	92.0%
		Positive	2 (4.8)	41 (89.1)							
	Total	Negative	61 (95.3)	7 (7.1)	0.873	<0.001	92.9%	95.3%	96.8%	89.7%	93.9%
		Positive	3 (4.7)	92 (92.9)							
Radiologist	Bone	Negative	6 (85.7)	2 (10)	0.724	<0.001	90.0%	85.7%	94.7%	75.0%	88.9%
		Positive	1 (14.3)	18 (90)							
	Soft tissue	Negative	28 (96.6)	1 (3.2)	0.933	<0.001	96.8%	96.6%	96.8%	96.6%	96.7%
		Positive	1 (3.4)	30 (96.8)							
	Total	Negative	34 (94.4)	3 (5.9)	0.882	<0.001	94.1%	94.4%	96.0%	91.9%	94.3%
		Positive	2 (5.6)	48 (94.1)							
Total	Bone	Negative	27 (93.1)	4 (5.5)	0.858	<0.001	94.5%	93.1%	97.2%	87.1%	94.1%
		Positive	2 (6.9)	69 (94.5)							
	Soft tissue	Negative	68 (95.8)	6 (7.8)	0.878	<0.001	92.2%	95.8%	95.9%	91.9%	93.9%
		Positive	3 (4.2)	71 (92.2)							
	Total	Negative	95 (95)	10 (6.7)	0.876	<0.001	93.3%	95.0%	96.6%	90.5%	94.0%
		Positive	5 (5)	140 (93.3)							

87.1%, and an overall diagnostic accuracy of 94.1%. Percutaneous Tru-cut needle biopsy performed for lesions originating from soft tissue had a sensitivity of 92.2%, a specificity of 95.8%, a PPV of 95.9%, an NPV of 91.9%, and a diagnostic accuracy of 93.9%. (Table 2).

(2) What should the approach be for patients not diagnosed with core needle biopsies?

A single percutaneous core needle biopsy was performed in 219 (89.8%) of 244 patients, resulting in the final diagnosis (compatible group). The approach to patients whose diagnosis could not be made with a single percutaneous core needle biopsy is discussed in this section. Four of the 25 patients are in the non-compatible group. There was no indication for repeating the biopsy in 11 patients. The remaining ten patients underwent a repeated biopsy. In this section, the results of the patients in this group are presented respectively.

In 4 of 25 patients whose definitive diagnosis could not be made by single needle biopsy, the result of needle biopsy and the final diagnosis obtained after surgery were different, and these patients were included in the incompatible group. Again, 21 of these 25 patients were included in the suspicious and non-diagnostic material groups, and only 10 had consecutive re-biopsy. Six of these patients had a repeated core-needle biopsy, and four had an open biopsy. Eleven patients who did not have re-biopsy were evaluated by the Bone and Soft Tissue Tumors Council, and surgical treatment was recommended.

Considering the final diagnosis of 10 patients (4.1%) who needed an additional biopsy, it was seen that three lesions originated from bone tissue and seven lesions originated from soft tissue. When the three lesions arising from the bone tissue were examined, it was determined that the first needle biopsy result of all 3 was in the "non-diagnostic material" group. An orthopedist performed the first needle biopsy in 2 of these three patients, and a radiologist in 1 of them. The orthopedist performed incisional (open) biopsy in all three patients to reach the final diagnosis; 2 patients were diagnosed with chondrosarcoma and one patient with a malignant neuroendocrine tumor.

When seven lesions originating from soft tissue were examined, 4 of the first needle biopsy results were in the "non-diagnostic material" group, and three were in the "suspicious" group. An orthopedist made the first biopsy attempt on all seven patients. Due to a lack of definitive diagnosis, a radiologist performed a second needle biopsy under image guidance on six patients, and an incisional (open) biopsy was performed on one patient by an orthopedist. When the final diagnoses of these seven patients were examined, it was seen that two patients were diagnosed with liposarcoma, one patient with lipoblastoma, one patient with intramuscular myxoma, one patient with pleomorphic sarcoma, one patient with spindle cell sarcoma, and one patient with metastasis. The lesion's tissue of origin, the lesion's location, the first biopsy result, the additional biopsy method, the additional biopsy result, and the final histopathological diagnosis of the ten patients who underwent additional biopsy procedures are presented in Table 3.

Table 3. Data of ten patients who underwent additional biopsy procedure

Bone/Soft tissue	Location of the lesion	First biopsy result	Additional biopsy method	Additional biopsy result	Final diagnosis
Bone	Sacrum	Non-diagnostic material	Incisional biopsy by an orthopedist	Chondrosarcoma	Chondrosarcoma
Bone	Scapula	Non-diagnostic material	Incisional biopsy by an orthopedist	Chondrosarcoma	Chondrosarcoma
Bone	Humerus	Non-diagnostic material	Incisional biopsy by an orthopedist	Malignant neuroendocrine tumor	Malignant neuroendocrine tumor
Soft tissue	Shoulder circumference	Non-diagnostic material	Imaging-guided biopsy by a radiologist	Squamous cell carcinoma metastasis	Metastasis
Soft tissue	Thigh	Non-diagnostic material	Imaging-guided biopsy by a radiologist	Myxoid liposarcoma	Myxoid liposarcoma
Soft tissue	Knee circumference	Non-diagnostic material	Incisional biopsy by an orthopedist	Spindle cell sarcoma	Spindle cell sarcoma
Soft tissue	Knee circumference	Non-diagnostic material	Imaging-guided biopsy by a radiologist	Lipoblastoma	Lipoblastoma
Soft tissue	Knee circumference	Suspicious lesion	Imaging-guided biopsy by a radiologist	Myxoid liposarcoma	Myxoid liposarcoma
Soft tissue	Trunk	Suspicious lesion	Imaging-guided biopsy by a radiologist	Malignant mesenchymal tumor	Pleomorphic sarcoma
Soft tissue	Thigh	Suspicious lesion	Imaging-guided biopsy by a radiologist	Intramuscular myxoma	Intramuscular myxoma

(3) Is there a difference in the diagnostic success of core needle biopsies performed with and without image guidance?

The diagnostic accuracy rate of fluoroscopy-guided percutaneous Jamshidi needle biopsy performed by an orthopedist for lesions originating from the bone is 96%. The diagnostic accuracy of percutaneous Tru-cut needle biopsy performed by an orthopedist without image guidance for lesions originating from soft tissue was 92%. The diagnostic accuracy of a radiologist's CT-guided percutaneous Jamshidi needle biopsy for lesions originating from the bone is 88.9%. The diagnostic accuracy rate of percutaneous Tru-cut needle biopsy under USG guidance, performed by a radiologist for lesions originating from soft tissue, was 96.7%.

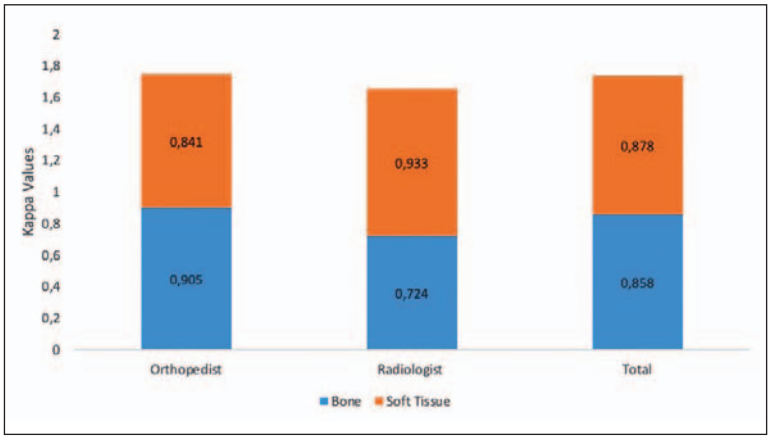

Fig. 2. Kappa (K) values showing the diagnostic agreement between percutaneous needle biopsy in bone and soft tissue lesions and the final histopathological diagnosis obtained from surgery, according to the physician performing the biopsy.

One hundred sixty-three lesions for which core needle biopsy was performed by an orthopedist and 87 lesions for which a radiologist performed core needle biopsy were separated as bone and soft tissue according to the tissue of origin and the results of percutaneous core needle biopsy and surgical biopsy were classified separately. Kappa values, which were calculated using the Pearson chi-square test and showed compatibility with the results, were examined. Accordingly, in the biopsies performed by the orthopedist, the kappa value was calculated as 0.905 in lesions originating from the bone and 0.841 in lesions originating from soft tissue. In the biopsies performed by the radiologist, the kappa value was calculated as 0.724 in lesions originating from bone tissue and 0.933 in lesions originating from soft tissue. These results show that better diagnosis was obtained in fluoroscopy-guided closed (Jamshidi needle) biopsies performed on bone lesions by the orthopedist and image-guided percutaneous (Tru-cut needle) biopsies performed on soft tissue lesions by the radiologist (Fig. 2).

DISCUSSION

All biopsy techniques aim to obtain an adequate tissue sample with minimal trauma, considering the limb-sparing surgical treatment approach. When conducting a biopsy on any mass, the physician has dual objectives. The primary goal is to establish an accurate diagnosis, facilitating the development of a definitive treatment plan. Simultaneously, it is essential to employ a technique that does not compromise the limb-sparing surgical treatment plan (28). The reported diagnostic accuracy of open biopsies, which has long been accepted as the gold standard diagnostic method in diagnosing bone and soft tissue tumors, ranges from 91% to 99% (18, 22, 24). In an article published by Mankin et al., the complication rate of open biopsies was determined as 16%, and it was observed that the treatment plan was affected by these complications in 8.2% of the patients. The same study found diagnostic errors based on open biopsy results in 1.2% of patients (14). Another disadvantage to consider is the high cost of open biopsies. A cost analysis study published by Skrzynski et al. found that open biopsy methods are seven times costlier than closed biopsy methods (24). It has been observed that core needle biopsies shorten the diagnosis time, and they have low cost and practical application. A study published by Kiefer et al. emphasized that the diagnosis is faster with core needle biopsies compared to open (incisional) biopsies (12). This study aimed to demonstrate percutaneous core needle biopsy's high diagnostic accuracy and reliability. This was achieved through a retrospective comparison between patients' preoperative core needle biopsy results and the final diagnoses obtained after surgical excision. We also examined the approach in patients who could not be diagnosed with core needle biopsies and analyzed the difference in the diagnostic success of image-guided and non-image-guided core needle biopsies.

(1) The success of core needle biopsies in the diagnosis of bone and soft tissue tumors

The diagnostic accuracy of core needle biopsies ranges from 76% to 99% in the literature (1, 2, 19, 22, 24). Our study achieved a high diagnostic accuracy rate with core needle biopsies, which is consistent with the literature. Looking at the biopsies performed by the orthopedist, the diagnostic accuracy rate of percutaneous Jam-shidi needle biopsy performed under fluoroscopy guidance for lesions originating from the bone is 96%; The diagnostic accuracy of percutaneous Tru-cut needle biopsy performed without image guidance for lesions originated from soft tissue was found to be 92%. When the biopsies performed by the radiologist are examined, the diagnostic accuracy rate of CT-guided percutaneous Jamshidi needle biopsy for lesions originating from bone is 88.9%. In comparison, the diagnostic accuracy rate of percutaneous Tru-cut needle biopsy performed under USG for lesions originating from soft tissue is

96.7%. Finally, regardless of the physician who performed the closed biopsy method, as a result of the statistical analysis of all biopsy results, the diagnostic accuracy of percutaneous Jamshidi needle biopsy for lesions originated from bone was 94.1%, the diagnostic accuracy of percutaneous Tru-cut needle biopsy for lesions originated from soft tissue was found to be 93.9%. For high diagnostic accuracy, cooperation between the physician applying this method and the pathologist, radiologist, orthopedist, and oncologist who will undertake further treatment is recommended (8). Patients evaluated with suspicion of tumors in our clinic were examined in the Bone and Soft Tissue Tumors Council from a multidisciplinary perspective before biopsy, and close cooperation and communication were ensured between all relevant physicians. In this way, we have achieved high diagnostic success.

(2) Approach for patients who cannot be diagnosed with core needle biopsies

A dilemma arises between repeating the biopsy or relying on radiological diagnosis in the presence of non-diagnostic and suspicious results (27). A second biopsy was required in 3 of the five biopsies interpreted as "suspicious," and 7 of the 16 biopsies analyzed as "non-diagnostic material" in our study. Considering the clinical and radiological data of the remaining 11 patients, they were evaluated in the council from a multidisciplinary perspective, and their surgical treatment was performed. As we mentioned, we have 10 (4.1%) patients who required repeat biopsy, which is consistent with re-biopsy rates of 3% to 25% reported in previous studies (17, 21, 30). In the series published by Yang et al., it was seen that the most common rate of repeat biopsy was in patients in the non-diagnostic material group (29). Like this published series, we found that the first biopsy result was reported as "non-diagnostic material" in 7 of the ten patients we re-biopsied. In patients who cannot be diagnosed with core needle biopsies, the clinical and radiological data should be reviewed and re-evaluated with a multidisciplinary approach, and a repeat biopsy or treatment approach should be determined as a result of this evaluation.

(3) Difference in the diagnostic success of image-guided core needle biopsies versus non-image-guided core needle biopsies

When previous studies are examined, the diagnostic accuracy of CT-guided core needle biopsies is between 77.3% and 97% (9-11, 13, 20, 26, 28), the diagnostic accuracy of USG-guided core needle biopsies varies between 83% and 97%, and both techniques have high diagnostic accuracy (5, 7, 25). In our study, the diagnostic accuracy of CT-guided percutaneous Jamshidi needle biopsy performed by a radiologist for lesions originating from the bone was 88.9%, and the diagnostic accuracy of USG-guided percutaneous Tru-cut needle biopsy performed for lesions originating from soft tissue was 96.7%.

Many studies compare imaging-guided needle biopsies with open (incisional) biopsies. However, the diagnostic accuracy of non-imaging-guided core needle biopsies needs to be better documented (18). This issue is fundamental in core needle biopsy of soft tissue tumors; there are only two studies on this subject. The study published by Pouedras et al. in 2021 has achieved high diagnostic accuracy with needle biopsies performed without image guidance for selected soft tissue tumors. They found no significant difference between the failure rates of image-guided and non-image core needle biopsies, emphasizing that the diagnostic delay was significantly shortened in non-image-guided biopsies (18). In a similar study by Narvani et al. in 2009, while an image-guided needle biopsy was performed in deep-seated and small-sized (<3 cm) soft tissue lesions, a needle biopsy was performed without image guidance in large (>3 cm), palpable, and superficial soft tissue lesions. As a result of this study, they recommended an image-guided biopsy, especially for deep-seated and small soft tissue lesions (16). Our study compared the diagnostic accuracy of a percutaneous Tru-cut needle biopsy performed by an orthopedist without image guidance for soft tissue with the diagnostic accuracy of a percutaneous Tru-cut needle biopsy under USG guidance for lesions originating from soft tissue by a radiologist. As a result, the diagnostic accuracy rate of image-guided Tru-cut needle biopsies applied for soft tissue lesions was higher (96.7%>92% and K:0.933>0.841). Especially if the soft tissue mass is heterogeneous, deep located, non-palpable, or close to neurovascular structures, we recommend image-guided biopsy in cooperation with the Radiology department.

The greatest strength of our study is that a single multidisciplinary team evaluated all patients and performed all diagnostic and treatment procedures. In addition, unlike most publications in the literature, in this study, the histopathological diagnosis obtained from core needle biopsy was compared with the final histopathological diagnosis obtained from surgical treatment. Thus, more precise results were obtained by comparing histopathological diagnoses between biopsies. The main limitation of our study is that it is retrospective. Another limitation is that the number of patients between the groups were not homogeneously distributed. In addition, complications resulting from core needle biopsy could not be evaluated in our study because there was no history of post-biopsy complications (infection, hematoma, etc.) in the patient's files. In patients with soft tissue sarcoma, data regarding the diameter and location of the lesion and its distance from the skin were unavailable in all patients, so these variables could not be examined statistically. Also, since the data on the diameter of the core needles could not be reached in the biopsy procedure records of the patients, the relationship between the needle diameters and the success of the biopsy could not be examined.

CONCLUSIONS

Biopsy plays a very important role in diagnosing bone and soft tissue tumors. When choosing the biopsy method, the possible diagnosis of the lesion, its anatomical location, the hospital's facilities, and the amount of tissue that the pathologist may need to diagnose should be considered. For this reason, in bone and soft tissue tumors, the patient should be evaluated together by experienced physicians working in the reference center. In answer to the first question we used when designing our study, in the light of the data we obtained, percutaneous needle biopsy is an extremely adequate and reliable diagnostic method. As we discussed in the second question, our approach recommendation for patients who cannot be diagnosed with core needle biopsy is that clinical and radiological data should be reviewed and re-evaluated multidisciplinary, and as a result of this evaluation, a repeat biopsy method or treatment approach should be determined. Our inference from the last question is that the diagnostic accuracy of image-guided core needle biopsies performed on soft tissue by a radiologist is higher than biopsies performed by an orthopedist without imaging (96.7%>92% and K:0.933>0.841). As a result, to have high diagnostic accuracy, patients should be examined by a multidisciplinary team, and the biopsy technique should be decided together (94%). We emphasize the need for close cooperation and communication between relevant physicians at every stage of the disease. We think that physicians' first choice of biopsy method in diagnosing bone and soft tissue lesions should be core needle biopsies.

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